

1. Introduction

Significant sudden wind gusts can pose a threat to aviation near the coastline, as well as small (sailing) boats and commercial ships approaching the ports. Such cases can result in wind speed changes of more than an order of magnitude within 5 minutes, which can then last up to 20 minutes or more. Although the constellation of scatterometers is a good means of studying maritime convection, those sudden gusts are not easily captured because of the low time resolution. The National Data Buoy Center (NDBC) provides continuous measurements of wind speed and direction along the US coastal regions every 6 minutes. Buoys are platforms placed at specific places on the seas, especially along coastlines, providing data for atmospheric and oceanic studies. Next Generation Radars (NEXRADs), after the recent upgrade of the network to dual-pol systems, offer enhanced capabilities to study atmospheric phenomena. NEXRADs provide continuous full-volume scans every ~5 minutes and therefore are close to the time resolution of the buoy measurements. Use of single-Doppler retrievals might also provide a means of further validation.

2. Objective questions

- How can we leverage the huge buoy dataset to identify past events?
- Is there a “best” radar proxy that reveals the onset of such gusts?
- Since buoys provide point measurements, how can single-Doppler analysis provide additional insights about the wind structure, considering that the measurement likely corresponds to a higher altitude than the buoy?
- How well do atmospheric models simulate the environmental conditions that lead to sudden wind gusts?

3. Method

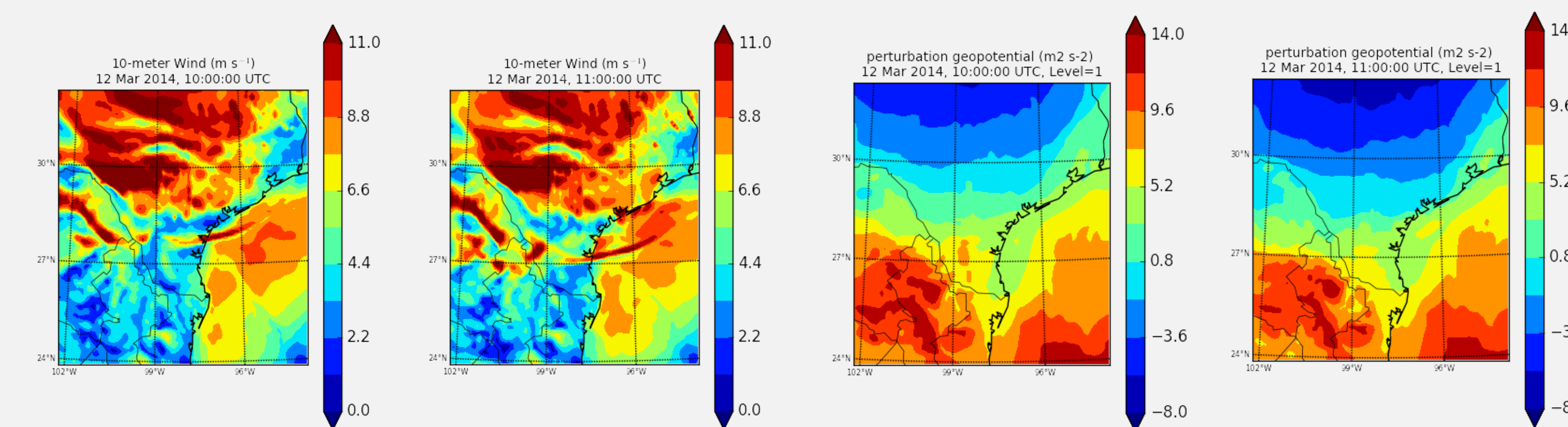
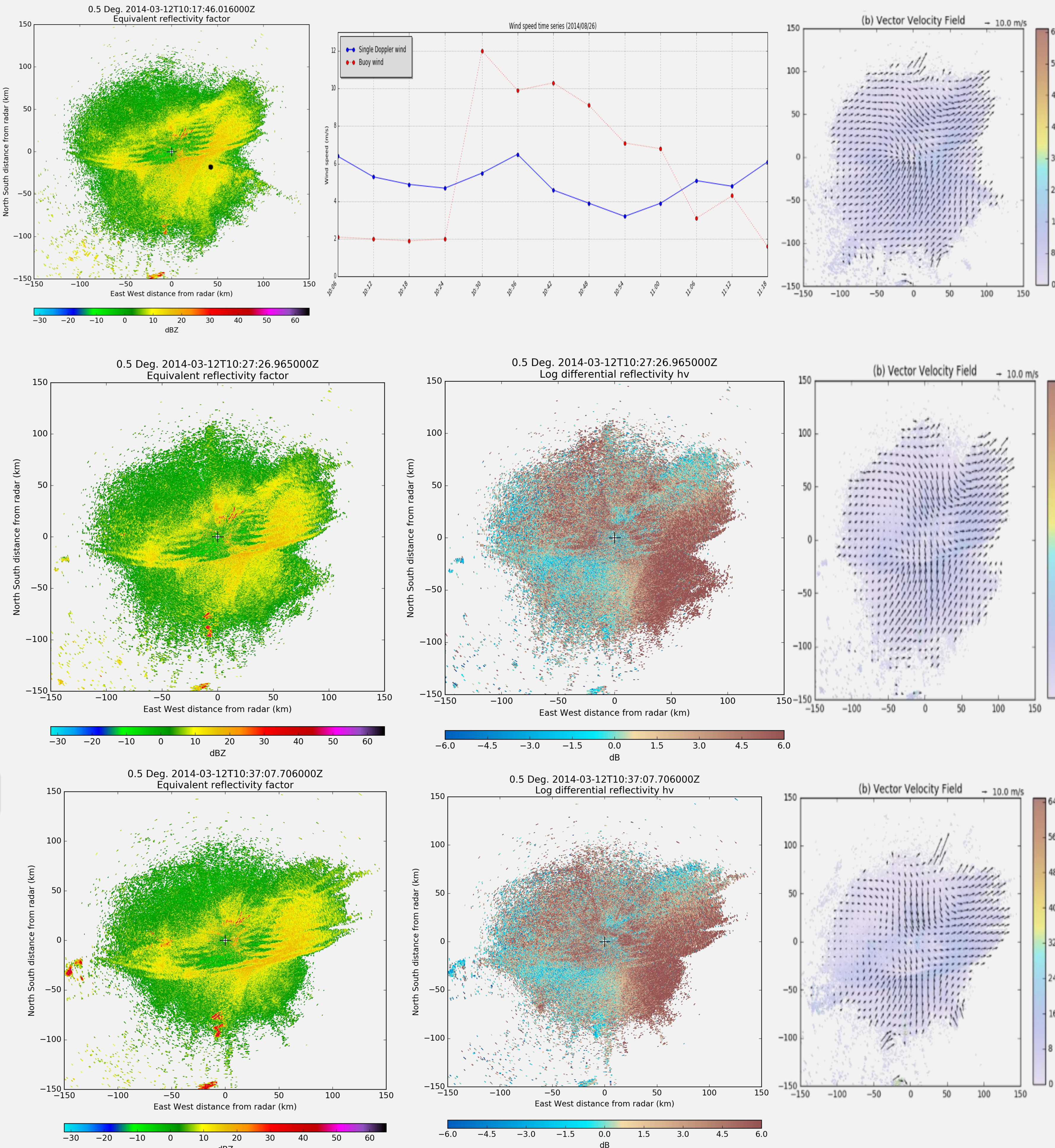
- The analysis is based on the buoy dataset.
 - Study period: 2013-2015 in order to match the NEXRAD network upgrade.
- Steps:**
- Retrieve buoy data along the US coastal region.
 - Find wind differences > 10 m/s for consecutive wind measurements.
 - Check that no bad data (-999) exist near the time for each case of the previous step.
 - To be categorized as sudden wind gust, at least 3 consecutive measurements should be of the same magnitude (high wind speed).
 - Retrieve corresponding wind direction.
 - Retrieve corresponding radar data, including two time steps before and after the time of the event.
 - Perform dual-pol retrieval and single-Doppler analysis. (The analysis leverages Py-ART and the code is developed by Timothy J. Lang and is freely distributed by <https://github.com/nasa/>.)
 - Perform any additional analysis.

Weather and Forecasting Model (WRF)

Case -> Corpus Christi	Case -> Houston
Input data: NAM	Input data: NAM
Grid resolution = 30, 10 km	Grid resolution = 12, 4, 1.3 km
Time resolution: 1 hr	Time resolution: 5 min
Physics scheme: 8	Physics scheme: 8
Lw, Sw_physics: 4	Lw, Sw_physics: 4
Surface_physics: 2	Surface_physics: 2
Pbl_physics: 1	Pbl_physics: 1

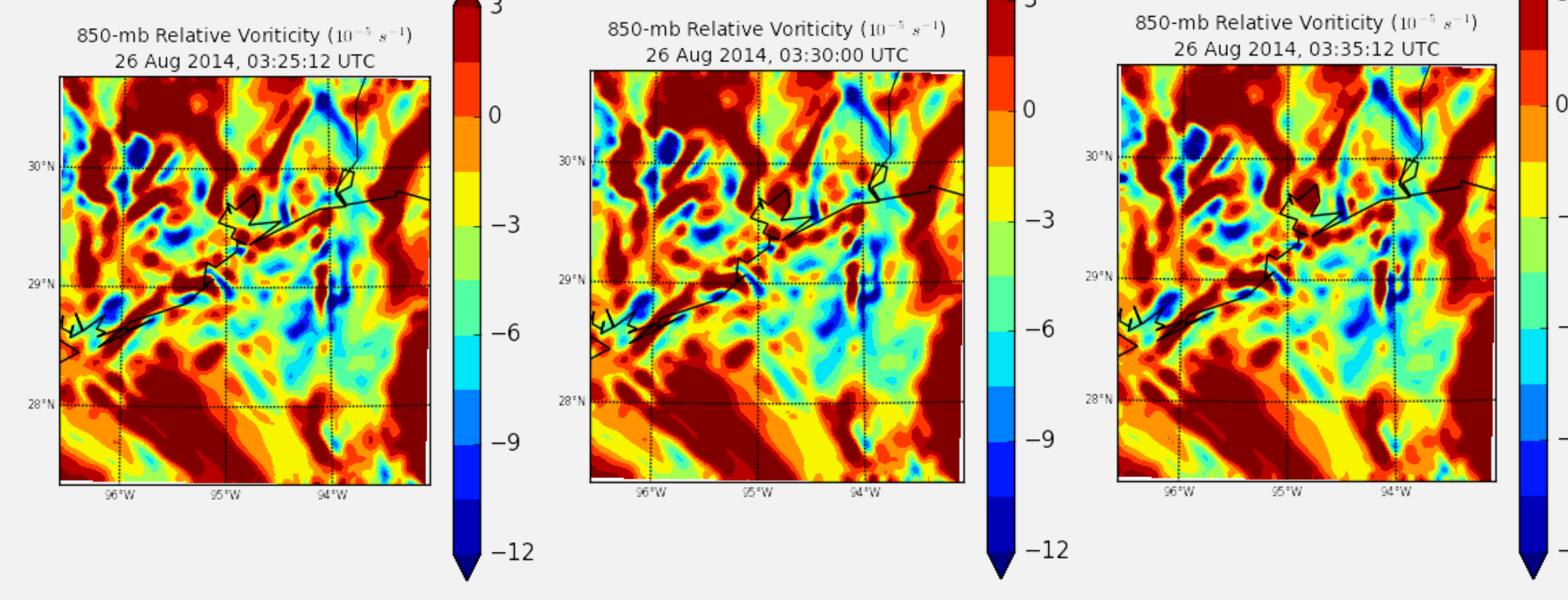
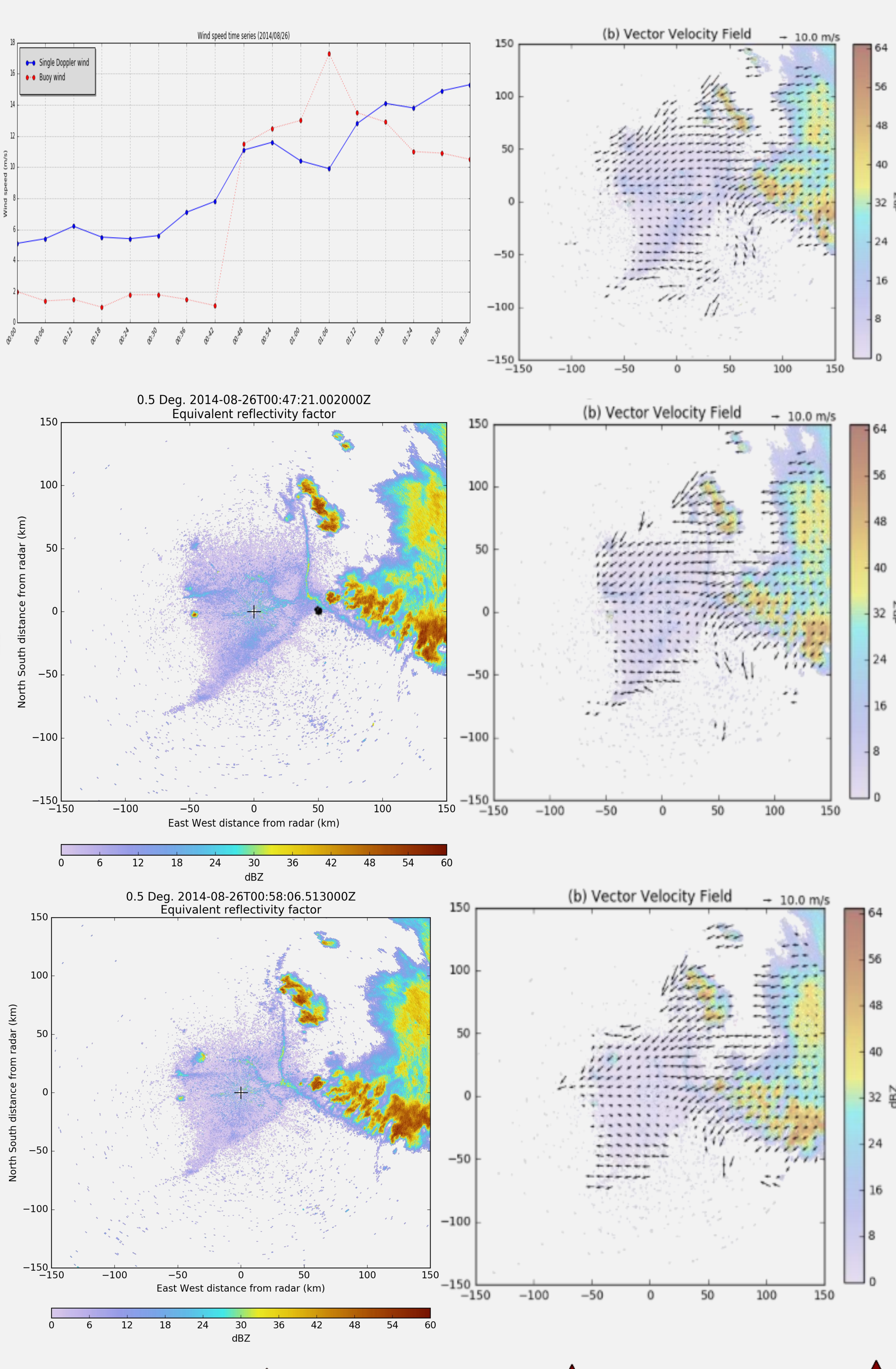
4a. Case: Corpus Christi (CP), TX 2014/03/12

Buoy station: PACT2 Increase in wind speed: 2 -> 12 m/s & difference in wind direction: 202°



4b. Case: Houston, TX 2014/08/26

Buoy station: RLOT2 Increase in wind speed: 1.1 -> 11.1 m/s & dir: 140°



5. Discussion

- The reflectivity values associated with the wave structure in the CP case are very low, therefore additional caution should be taken into consideration by the observer.
- Single Doppler analysis indicates convergence at the leading edge of the wave structure, although the sample of “valid” data is small (no valid data close to the buoy).
- WRF model captured the sudden increase in wind speed, in the CP case associated with a wave coming from the North as indicated by the variables.
- At the H case, the wind gust associated with the bow echo was captured by WRF in the 850 vorticity and 10 meter wind speed (not shown here) variables, among others.
- In the presence of a thunderstorm (not shown here) the VIL/VILD variable appeared to be the most indicative proxy, probably associated with the downdraft.
- Zdr and rho are found to be the most consistent proxies, unless the data are very noisy.